DOCUMENT RESUME

ED 427 068 TM 029 449

AUTHOR Yarbrough, Sondra J.; Daane, C. J.; Vessel, Amy Massey
TITLE An Investigation of Ten Elementary Teachers' Quantitative Literacy Instruction as a Result of Participation in the Alabama Quantitative Literacy Workshop.
PUB DATE 1998-11-00
NOTE 24p.; Paper presented at the Annual Meeting of the Mid-South Educational Research Association (27th, New Orleans, LA, November 4-6, 1998). Light print in middle of page appears throughout document.
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Elementary Education; *Elementary School Teachers; *Inservice Teacher Education; *Mathematics Instruction; *Mathematics Teachers; Probability; Statistics; *Workshops
IDENTIFIERS *Alabama

ABSTRACT

Two colleges of the University of Alabama have established the Alabama Quantitative Literacy (AQL) Workshop in an effort to prepare teachers to teach statistical techniques accurately and effectively and to enhance the ability of teachers to create new activity-based lessons. The AQL Workshop aims to achieve goals of the National Council of Teachers of Mathematics and the American Statistical Association for teacher preparation. The Workshop was initially designed to provide hands-on instruction in probability and statistics for 20 elementary and 20 secondary school teachers each year through 3 one-day sessions and a 6-day session in the summer. How elementary school teachers used this instruction was studied with 10 teachers who completed surveys and interviews and were observed in the classroom. All the data indicate that the AQL Workshop had a positive impact on teachers. This representative group of teachers indicated that they used the information they received at the AQL Workshop, and that their students received increased instruction in probability and statistics. The teachers demonstrated that they have the ability and confidence to adapt and generate appropriate quantitative literacy lessons to engage students in probability and statistics. (SLD)

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An Investigation of Ten Elementary Teachers' Quantitative Literacy Instruction as a Result of Participation in the Alabama Quantitative Literacy Workshop

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Sondra J. Yarbrough

C. J. Daane

Amy Massey Vessel

College of Education
The University of Alabama
P. O. Box 870231
Tuscaloosa, Alabama 35487-0231

TM029449

This paper was prepared for presentation at the meeting of the Mid-South Educational Research Association, New Orleans, Louisiana, November 4-6, 1998.

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The growth of technology and simplification of statistical methods during the 20th century have been instrumental in the formation of a society which makes extensive use of large amounts of quantitative data. This increase in the use of data to make decisions and predictions has created a need for individuals to understand how information is processed, translated, and interpreted. Therefore, it is critical that individuals have an understanding of the concepts and processes applied in the analysis of data and the interrelatedness of statistics and probability.

The National Council of Teachers of Mathematics (NCTM) has recognized the importance of preparing students to function in a technological society which is permeated by quantitative data. In the document, The Curriculum and Evaluation Standards for School Mathematics (Standards) (NCTM, 1989), it was recommended that the curriculum for Grades K – 4, should include experiences with data analysis and probability so that students can:

1. collect, organize, and describe data;
2. construct, read, and interpret displays of data;
3. formulate and solve problems that involve collecting and analyzing data; and
4. explore concepts of chance (p. 54).

Curriculum guidelines set forth by NCTM (1989) for the middle school grades encourage students to formulate questions, collect and organize data, represent data using various methods, analyze data, make conjectures, and communicate information in a convincing way. It has also been recommended by NCTM that as students study probability through experiments and simulations, they should make hypotheses, test conjectures, and refine their theories on the basis of new information. The use of charts and graphs by students as they experiment and participate in simulations with probability has been encouraged so that interpretations of information might

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be reinforced. The recommendations for the Grades 5-8, mathematics curriculum include exploration of statistics in real-world situations so that students can:

1. systematically collect, organize, and describe data;
2. construct, read, and interpret tables, charts, and graphs;
3. make inferences and convincing arguments that are based on data analysis;
4. evaluate arguments that are based on data analysis; and
5. develop an appreciation for statistical methods as powerful means for decision making (p. 105).

It has also been stated that in Grades 5–8, the mathematics curriculum should include explorations of probability in real-world situations so students can:

1. model situations by devising and carrying out experiments or simulations to determine probabilities;
2. model situations by constructing a sample space to determine probabilities;
3. appreciate the power of using a probability model by comparing experimental results with mathematical expectations;
4. make predictions that are based on experimental or theoretical probabilities; and
5. develop an appreciation for the pervasive use of probability in the real world (p. 109).

The Standards (NCTM) have recognized that statistical data, summaries, and inferences are the most common form of mathematical analysis in the work and everyday lives of people. In addition, a well-grounded understanding and intuitive notion about statistics and probability, based upon experiences, are vital to the development of quantitative literacy.

Prior to the publication of the Standards, but as part of the same movement, which recognized the need for improved probability and statistical instruction, the American Statistical Association (ASA) designed the Quantitative Literacy Project (Garfield & Ahlgren, 1994). This project, funded by the National Science Foundation, was an effort by NCTM and ASA to establish goals which could guide the instruction of probability and statistics at the elementary,

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middle, and secondary levels (Burrill, 1990). The ten guidelines developed by this joint effort are the following:

1. Experiences (activities) for students should be focused on asking questions about something in the students' environment and then finding quantitative ways to answer the question.
2. Problems should be approached in more than one way with an emphasis on discussion and evaluation of these different methods.
3. Real data should be used whenever possible in any statistics lesson, and classroom presentations should give students hands-on experience in working with data.
4. Traditional topics in statistics should not be taught until students have experiences and worked with simple counting and graphing techniques, and have established a foundation for those traditional ideas.
5. The emphasis in teaching statistics should be on good examples and intuition, not on probability paradoxes or using statistics to deceive.
6. Student projects should be an integral part of any work in statistics.
7. The emphasis in all work with statistics should be on the analysis and the communication of this analysis, not on a single answer.
8. Statistics should not be taught as a separate unit, but should be introduced whenever appropriate to illustrate and expand upon standard concepts (such as measurement), and to form interdisciplinary links for students.
9. The progression should be from the concrete, to the pictorial, to the abstract.
10. Calculators should be used extensively. Where appropriate, computers are a valuable aid (Garfield & Ahlgren, p. 91)

Burrill noted that these guidelines were congruent to those set forth in the Standards and could be instrumental to teachers as they attempted to implement these recommendations.

The preparation of teachers to provide instruction according to these guidelines presented a two-fold concern. First, teachers had little, if any, experience in providing instruction through hands-on learning strategies and simulations as recommended by NCTM and ASA. Secondly, teachers had little background in probability and statistics instruction. This was especially true at the elementary and middle school levels which have not emphasized probability and statistics in the curriculum until recent years.

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The College of Commerce and Business Administration and the College of Education at the University of Alabama have collaboratively established the Alabama Quantitative Literacy (AQL) Workshop, in an effort to achieve the goals established by the ASA and the NCTM. One of the specific goals of the AQL Workshop is to prepare teachers to teach statistical techniques accurately and effectively. An additional aim which the AQL instructional team established was to enhance the teachers' ability to create new activity-based lessons as well as use existing lessons (Mansfield, 1995).

The development of the AQL Workshop was based on the ASA's Center for Statistical Education model which had already been implemented successfully in several states (Mansfield, personal communication, April 1998). The AQL workshop was initially designed to provide hands-on instruction in probability and statistics for 20 elementary school teachers and 20 secondary school teachers per year. The instructional team consisted of five professors from the Departments of Statistics, Elementary Education, and Secondary Education. In addition, four classroom teachers were included on the instructional team. The workshop was planned to extend over a 12-month period in order to establish a means by which teachers could receive guidance to refine and re-direct activities that had been attempted in the classroom.

The workshop covered 9 days of instruction, three individual days and an intense 6-day session in the summer. The first session was held prior to the end of the school year in May. This was an introductory session to prepare the teachers for the summer session. It presented the philosophy of the workshop and gave the teachers a feel for what was to come. The 6-day session was conducted in July. The two follow-up sessions were held in October and in March. These sessions gave the participants time to share classroom experiences and receive more

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guidance and support from the AQL instructional team. The AQL workshops have been conducted each year since May of 1996. The last workshop was expanded to include 60 teachers, 20 each from Grades K-4, 5-8, and 9-12.

Purpose of the Study

The responses to the semi-formal evaluations from the teachers regarding the benefits of the workshop were encouraging. These positive responses were further supported by the numerous unsolicited favorable comments from participating teachers. However, no formal investigation was made to examine what impact, if any, the workshop had on instructional practices in the classrooms.

The purpose of this study was to investigate the ways in which instruction from the AQL Workshop were utilized by elementary teachers who attended the workshop during the summer of 1997. The study focused on the extent to which the teachers were able to implement instructional strategies from the workshop and increase instruction in quantitative literacy skills and to what degree the goals set forth by the Quantitative Literacy Project were being met.

Research Questions

The following questions were used as the focus of this study.

1. How are teachers implementing the activities presented at the workshop to provide instruction in quantitative literacy?

2. When quantitative literacy instruction is being provided, in what context does it occur?

3. Do teachers believe that their instruction in quantitative literacy has changed as a result of attending the workshop?

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Participants and Setting

Ten of the 20 elementary teachers who attended the AQL Workshop in the summer of 1997 were selected as participants for this study. A purposive sampling was chosen as these teachers were selected based upon geographical location and their willingness to cooperate with classroom observations.

The selection of teachers that were invited to participate in the workshop provided a diverse group of teachers for this study. The teachers selected for the study consisted of two kindergarten teachers, a first-grade teacher, two second-grade teachers, a third-grade teacher, a fifth-grade teacher, two sixth-grade teachers, and a teacher of gifted students for Grades K-5. The teaching experience of the teachers ranged from 2 years to 23 years. With the exception of one male teacher, all participants were female.

The schools at which these teachers taught included inner city schools, suburban schools, and small rural schools. Some of the classes were taught in new buildings, others were taught in very old buildings while several were taught in mobile units. Computers were present in all the classrooms, but in some cases, the computers available were outdated. The kindergarten, first-grade classes, and one of the second-grade classes had a section of the floor covered with a rug or carpet so students could sit on the floor for lessons. Tables, which promote collaborative activities, were present in many of the lower grade classrooms. However, 6 of the 10 classrooms observed had individual desks rather than tables.

Although the quality of the facilities in which the classes were taught varied greatly, there were many similarities in the classrooms. The lack of sufficient storage space was apparent in every classroom. All teachers had made an attempt to make their rooms attractive and orderly.

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but the various shelves, storage cabinets, and baskets resulted in a disorderly appearance. A large portion of the wall space was used to display student work in all of the classrooms.

Positionality

My affiliation with the AQL Workshop began in the spring of 1996 when I was selected as a participant at the secondary level. In the summer of 1997, I was an associate at the secondary level of the workshop. Therefore, my experience with the workshop was primarily at the secondary level, but because of the structure of the workshop, I had met the participants in the study. Being an associate at the secondary level of the workshop in the summer of 1997, made it impossible for me to have experienced the elementary instruction provided at the workshop. However, my participation in the workshop as a teacher and my experience implementing some of the quantitative literacy learning activities in the classroom provided a common ground for the elementary teachers and me.

The second researcher, a professor at the University of Alabama in Elementary Mathematics Education, is one of four people who developed the AQL program. She has been an instructor with the elementary level of AQL since it's inception.

The peer debriefer and third author is a former elementary classroom teacher who currently teaches elementary education courses at the University of Alabama. Her teaching experience at the elementary level and research background provided a reliable source for analyzing the data.

Data Collection

The sources of data were field notes taken during classroom observations and transcriptions of teacher interviews of the ten participants. This data was collected over a 15-

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week period. An open-ended survey was administered to the elementary teachers who returned for the second follow up session of the workshop in the spring of 1998. Additional documents included photographs taken during the classroom observations, student work, and information sheets completed at the beginning of the workshop.

Each of the ten teachers selected for the study was observed teaching a quantitative literacy lesson. The lessons generally lasted approximately 50 minutes. Field notes were taken during the observation and then transcribed for analysis. Audio tape recordings of the class were made in order to verify the field notes when necessary.

Semi-structured interviews were conducted either on The University of Alabama campus or at the schools where the teachers taught. All of the interviews were conducted after the classroom observation of the teacher had been completed. The interviews lasted from 10 to 40 minutes with the average length being 20 minutes. All interviews were audio taped and transcribed for analysis.

Data Analysis

The analysis of the classroom observations, the teacher interviews, and the open-ended questions on the survey involved the process of identifying, coding, and categorizing the primary patterns of the data (Patton, 1990). Several strategies suggested by Wolcott (1994) to analyze data in qualitative studies include highlighting the findings, displaying the findings in tables and charts, and identifying patterned regularities in the data. These strategies, along with a constant comparative analysis, were extremely helpful in uncovering the overarching themes of the study and in validating the initial findings.

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The research questions were used to guide the initial analysis of the field notes and interview transcriptions. The analysis of the field notes from the classroom observations indicated possible emerging themes that were used to establish the initial categories for further analysis. The interview transcriptions were then analyzed through a coding process. The constant comparative analysis helped to refine the initial categories. Finally, the open-ended questions on the surveys were analyzed to validate the findings. Peer debriefing was completed by the third author who coded the data and compared her findings with the primary researcher.

Credibility of the study was strengthened through the triangulation of data sources (Patton, 1990). This triangulation was achieved by comparing and cross-checking the field notes from the classroom observations and the transcriptions of the teacher interviews. The open-ended survey provided a third source to substantiate the analysis of the data. The combination of observations, interviews, and document analysis provided different data sources to support the findings.

Findings

Careful analysis of the data revealed several themes related to the research questions. The following three sections discussed below include the implementation of quantitative literacy activities, the context in which quantitative literacy activities took place, and teacher perceived changes in quantitative literacy instruction. A fourth section includes additional findings from the data analysis. Each section identified will be supported by samples taken directly from the data.

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Implementation of Quantitative Literacy Activities

The first research question addressed the ways in which the classroom teachers implemented the activities presented at the AQL workshop. One theme was effective implementation of AQL activities. The analysis of the data revealed that teachers were using the information, the activities, and the materials they had obtained from participating in the workshop. The data indicated that teachers were implementing quantitative literacy instruction along a continuum that ranged from imitating the actual workshop activities to the generating of activities originating from workshop activities, books received at the workshop, and additional sources.

Two observed lessons clearly resembled what was presented in the workshop. One of these was a cereal sampling activity which was done by a second-grade teacher. This particular activity involved organizing, analyzing, and interpreting data as well as predicting outcomes. Students discovered if their sample of cereal was a representative of the total cereal found in the entire box. Several lessons, which were taught, involved the collecting of data to make bar graphs. The emphasis of the lesson and the questions asked were very similar to those posed during the workshop. During the interviews teachers often made the same comments as one 6th-grade participant. The teacher explained that she was doing the activities as they were presented in the workshop but she had "expanded on the graphs."

The adaptation of activities learned in the workshop was a common occurrence in the teachers' classroom experience. These adaptations and modifications occurred, because the level of difficulty was not appropriate for the students or because changes could be made which made the activity more relevant to other topics being taught. For example, one kindergarten

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teacher referred to an activity in which data concerning the frequency of letters in a newspaper was collected. Her explanation was that there are too many words in a newspaper article and

> …it would just take too much time for my children to do that. We're going to do it as a kangaroo poem because we are studying about Australia and it's on chart paper and I'll make a big paper for at least the intro activity. . .and we'll tally it as a whole group and then we can try small groups.

A first-grade teacher did an activity similar to the M & M's activity but used candy dinosaurs when she taught a unit on dinosaurs. The M & M's activity involved gathering data, interpreting graphs, displaying data, drawing and evaluating conclusions, and exploring probability. She stated, "I made my own little graph and we took the little gummy dinosaurs and they had to make a prediction and then count and then we graphed our dinosaurs."

The need to make adaptations to the activities learned in the workshop did not appear to be a problem for these teachers. One teacher stated, "I enjoyed the workshop because it gets me thinking. . . Some of it I may be thinking, this is a little bit high for them [first-grade students] so I'll redo something, but it gives me an idea." Another teacher expressed the view that regardless of the level of instruction at a workshop, modifications may need to be made once the teacher is back in the classroom teaching the lesson to his or her students.

A graphing project was generated by a kindergarten teacher one day when a student noticed that he and the teacher had the same brand of potato chips for a snack. The class then began collecting chip bags which the teacher glued onto paper on the wall to make a bar graph of the different brands of chips. The teacher stated, "That was the best project! It hung up in the classroom from the ceiling for about a month or so."

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A sixth-grade teacher derived an idea for determining the length of the flight of paper airplanes using the variables of flaps which were part of the design of the airplane based on the ghost activity from the workshop. In this activity, the students gathered, classified, and graphed data after developing a way for a paper-made ghost to spin in the air as it "floats" to the ground. The teacher explained that while participating in a space camp workshop he was presented with the instructions for making a plane with flaps. He recounted the experience of developing the idea in the statement,

> They handed me the instructions for making the airplane and I didn't learn anything else that class because I was thinking of things I could do with that. This is something I could do. We did the ghost and we attached the paperclips and we watched it rotating and decided where and how to fold the arms and make it go down faster or slower. And so you know I thought there are two flaps, four flaps on this wing and we can manipulate those and fly it and see if that has any effect.

A second finding pertaining to the implementation of activities presented at the AQL workshop revealed that the teachers' instruction in quantitative literacy skills was not always accurate. For example, in one lesson, students were constructing a line plot to represent the results of a survey of favorite local news stations. Students were instructed to place "x's" on a bulletin board to represent responses to a survey. As students placed the "x's" above the appropriate headings, different sizes of "x's" appeared. This was especially true for one of the categories because of the large number of favorable responses. As the "x's" approached the top of the bulletin board, the size of the "x's" decreased. When a student commented that they were "out of room," the teacher instructed him to "start another line." The student then began to mark "x's" in the direction from top to bottom. A second problem with this method, of constructing a line plot, was that the vertical lines were not straight. These inconsistencies created a misleading

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graph. However, the greater error which occurred during this lesson was that, after completing the line plot, the "x's" were counted for each station and these numbers were used to calculate the mean and median.

Another error occurred in a lesson, in part due to an inappropriate handout given to the children. Students completing the M & M's activity were asked to place a colored candy on a sheet of paper on which 13 circles had been drawn to aid in the placement of the candy. The problem occurred when more than 13 candies of one color were contained in a bag. When students informed the teacher that they had more candies than would fit on the circles, they were instructed to leave the extras off the graph. This response to the situation resulted in distorting the data.

Context of Quantitative Literacy Instruction

The second research question addressed the context in which teachers used activities to provide instruction in quantitative literacy skills. Data from the study indicated that students were engaged in questioning and discussion throughout quantitative literacy lessons. It was also evident that teachers integrated the teaching of probability and statistics throughout the elementary curriculum.

One notable characteristic of all quantitative lessons taught was the element of discussion with students. These discussions included making predictions, questioning students about probability, asking students to consider alternatives to answers given, determining multiple ways to represent data, and looking for patterns among data collected. For example, during a second-grade lesson using Fruit Loops, the teacher conducted a whole class discussion concerning student predictions of which color occurred most frequently, which color actually

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occurred most frequently, which color occurred the least frequently, and why the students might have made a wrong prediction. The teacher also discussed with students that they had only used a sample and that if they used a different sample their results might be different. This was followed by a discussion of how the size of the sample is important when a representation of the population is desired.

Another second-grade lesson involved the teaching of probability. A diagram to represent a spinner similar to the one below was displayed on the chalkboard.

After the teacher asked, "If you spin 20 times, where would it land the most?" the students discussed the spinner and decided that three would be the most likely event. In response to the teacher asking the students for an explanation of the answer the students explained that because the one and two could be combined to make the same amount of space as the three. The teacher then asked the students to make a prediction about whether the spinner would land on one or two more frequently. One student said that it would make a difference whether the spinner is spun clockwise or counterclockwise. Approximately eight students said that it would land with the same frequency on one and two, irregardless of the direction of the spin. Another student stated that the frequency depends on how hard the spinner is spun. A third student said that she disagreed "because one and two are the same size space" and "they will be the same." Two other students agreed with this answer. The student who believed that the direction of the spin was a

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factor then said that he agreed with the student who said "they will be the same." The student who stated the force of the spin made a difference said that he disagreed with himself because of what he heard someone else say and because of what he remembered from a previous lesson.

Another theme that was prevalent during the lessons observed and in the lessons described in the interviews was the innovation with which teachers integrated graphing and probability across the curriculum. One teacher stated that attending the workshop had "expanded the whole curriculum for me. I can look at any subject now and see how I can use some of these activities."

The integration of quantitative literacy activities included graphing data about the weather which had been collected by the students; using Venn diagrams to compare and contrast in reading and social studies; making bar graphs in science and social studies; and finding the mean, median, and mode of weekly test scores. Many teachers stressed that they did graphs on "everything." Their statements were supported by the large amount of graphing samples that appeared in their classrooms and the ease with which students answered questions pertaining to probability and statistics.

A second-grade teacher emphasized that additional mathematics skills were easily incorporated into the quantitative literacy activities in the statement, "When you're doing the graphing and the sorting and all that, you're also teaching adding and subtracting and problem solving." A third-grade teacher had incorporated the teaching of less than and greater than comparisons when using the M & M's activity by discussing with students the adding of candies of different colors to make more of another color combination.

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One kindergarten lesson which I observed during the month of February integrated the reading of a story about George Washington Carver, map skills, and graphing as well as motor skills. During the reading of the story of George Washington Carver and his development of the uses of peanuts, children were asked to locate different locations, such as Africa and Alabama, on a world map. After the story, students were given peanuts in a shell, peanuts from a jar which had been shelled, and some peanut butter to taste. The teacher distributed papers on which there was a picture of a peanut. The students were instructed to color and then cut out the peanut after they decide which way they prefer to eat their peanuts. The children took turns going to a sheet of paper to glue their peanut above the icon which represented their preference. The line plot formed by the "peanuts" was then used to discuss the most popular and least popular way of eating peanuts.

A similar lesson taught by a kindergarten teacher involved the reading of a book entitled The Crayola Counting Book, which was followed by children being given a box of crayons, instructed to sort by color, and then graph the number of crayons according to the way which they had selected to sort the crayons. During a whole group activity, a large box of crayons were displayed and students were asked to predict the number of crayons in the box. The estimates which were written on "post-it" notes were used to form a bar graph on the dry erase board at the front of the room. This activity was followed by making a graph of students' favorite colors, given the choices of red, yellow, pink, orange, and green. Art was finally integrated as children were instructed to draw a picture using only their favorite color.

The integration of quantitative literacy instruction was also prevalent in statements such as "Mine has not been like a whole unit--like a two week unit on it. It's just at different times,

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whatever theme I'm doing I put things in." Many teachers readily recalled incorporating statistics and probability into activities they had done throughout the school year.

Teachers' Perceptions of Instructional Changes

The third research question addressed the teachers' perceived changes in their instruction of probability and statistics. It was evident from the data collected that teachers felt that their instructional time in quantitative literacy had increased and their confidence in teaching in those areas had grown.

An increase in the amount of quantitative literacy instruction was apparent in the numerous comments made by teachers such as "I've used so many different things this year, from so many different places" and "We've done so much with probability and statistics this year." An experienced teacher expressed the belief that "Even though I had used it [probability] before, I don't think I focused on it as much as I did this year. . . I know I didn't." The increased amount of instructional time pertaining to quantitative literacy was also evident in the following statement by one of the participants:

> I think without the books that we've gotten and the lessons that have been presented, without attending these workshops I would have never done any of this [quantitative literacy activities]. . . I would have steered absolutely clear of anything that resembled the word "statistics." I had no idea it could be so much fun. . . I had no idea that children could grasp the math concepts like they do so early and so quickly and enjoy it so much at such a young age.

One teacher shared that a fellow teacher had commented to her several times, "Man, you're always doing graphs. You're always thinking of graphs." The teacher's response to the remarks had usually been, "No, it's that workshop I went to and the books I got."

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Knowledge of graphs was a common response to questions concerning the benefits of attending the workshop. For example, one teacher stated, "I feel like I'm more knowledgeable." Another example of the impact of the knowledge gained during the workshop came from a kindergarten teacher who stated,

> I've got so many graphs up in my room and the children have really caught on to it, but what I really, really, keep remembering from the workshop anytime that we do the activities are. . . the discrepancies in the graphs.

The teacher discussed this several times in the interview and the need to find "something that they [kindergarten students] are going to be able to space out to where they can line up each row" when doing a pictograph or line plot with students.

Increased confidence in the ability to teach quantitative literacy was also evident in statements made by teachers such as, "I just thought it up and I thought it would be a good graph activity and I guess I got it from having been exposed to what I saw at the workshop" when asked about the source for activities not presented at the summer workshop. The teachers confidence and enthusiasm in teaching quantitative literacy was also apparent in statements such as "I would have never done these type of activities before these workshops," and "I found that it was easy to teach these things [probability and statistics]."

The increased instructional time for quantitative literacy and the teachers' confidence and enthusiasm in providing instruction in this area were also evident in teachers' statements from the surveys. Some of the responses to the question, "How did your opinion of probability and statistics change from before the workshop to now?" included "Greatly! I now have confidence, ability, and tools to do a better job teaching these topics," "It's fun. I smile when teaching it instead of frowning when I think about teaching," and "I became more aware of the need to

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spend time on these in the classroom." Another teacher responded, "Before--statistics and probability was just a chapter in the book that I usually didn't get to. After--I start my school year with statistics and probability and apply the skills throughout the year."

Additional Findings

The follow up workshop sessions is an important feature of the AQL Workshop. Throughout the interviews, teachers emphasized the importance of discussing ideas with other teachers during the workshop. One teacher said, "I like the exposure of listening to the other teachers and the experiences they had and some of the ideas that they had I thought were good."

The following incident is an example of how sharing ideas can increase and improve instruction in quantitative literacy. During the spring post-session, the teacher who had developed the idea of manipulating flaps on paper airplanes and collecting data to determine the best position for the flaps shared his idea with the group of elementary teachers. Later that day, the teacher of gifted students explained the idea she had developed as a result of listening to the idea about the paper airplanes. Her recollection and explanation of the idea was

> Once he said that I started thinking, "Man, yeah, I can really integrate this statistics stuff more than is in the unit. . .that is already ready." So yes, I intend to do that. Maybe graph results, predict why one shape airplane might be best for the length contest or, there's one that reminds me a lot of the ghost activity, the spinning ghost. A plane that can do turns in the air. . . I think my unit will be perfect for that.

The implementation of quantitative literacy activities across the curriculum, the teachers' adaptation of activities, the student discussion that is prevalent during the instruction, and the apparent increase in the teaching of quantitative literacy skills are important indications that quantitative literacy instruction is being affected by the AQL Workshop. The number of graphs

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displayed in the classrooms, the ease with which students answered questions about graphs and probability, and the enthusiasm with which teachers discussed the changes that had occurred in their teaching as a result of attending the workshop provided more evidence that the goals of the AQL Workshop are being achieved.

Summary

The classroom observations, the teacher interviews, the open-ended surveys, and the additional documentation supplied sufficient data to indicate that the Alabama Quantitative Literacy Workshop has had a positive impact upon these elementary teachers. This representative group of Alabama teachers who participated in the AQL Workshop have indicated that they have made use of the instruction they received at the workshop. With the knowledge they gained from the workshop, students in the elementary grades have experienced an increase in probability and statistics instruction. These teachers have demonstrated that they have the ability and confidence to adapt, modify, and generate appropriate quantitative literacy lessons that engage students in the learning of probability and statistics.

These findings indicate that many of the goals established by the NCTM and ASA are successfully being implemented in the elementary mathematics classroom. Students were observed collecting real data, as well as, using simple counting and graphing techniques. In addition, the classroom environments supported student discussion and problem solving. Samples of student projects were displayed in the classrooms, and statistics and probability were integrated into the elementary curriculum.

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Future research should include studies similar to this one at the elementary, middle, and secondary levels. Additional studies should also include the continued investigation of teachers' instruction in order to study the long term results of participation in the Alabama Quantitative Literacy Workshop. It is recommended that an investigation be conducted to locate possible ways of eliminating the few incidences of instructional errors which were made during the teachers' quantitative literacy lessons.

The instructional team of the Alabama Quantitative Literacy Workshop is to be commended for their efforts in providing classroom teachers with the knowledge and resources to develop skills in students that will enable them to function in a society which requires extensive use of quantitative data. The work done during the past two summers and the expansion of the workshop appear to be a move in the right direction to meet the goals established by the ASA and the NCTM that students will be able to process, translate, and interpret quantitative data.

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